

CLAIMS

1. (Amended) A display device comprising:

display means in which, by applying voltages to row electrodes and column electrodes, the state of cholesteric liquid crystal is changed to display information;  
5 a row driver for applying a voltage to the row electrodes;

a column driver for applying a voltage to the column electrodes;

10 row-driver-reference-voltage switching means for selectively switching a first reference voltage supplied to the row driver between a first voltage having a voltage value greater than the absolute value of the bipolar voltage required for setting the state of the cholesteric liquid crystal to a planar state, and a zero volts;

15 column-driver-reference-voltage switching means for selectively switching a second reference voltage supplied to the column driver between a second voltage whose absolute value is equal to the first voltage and which is reverse in polarity to the first voltage, and zero volts; and

control means for controlling the operation of the row driver and the column driver, the row-driver-reference-voltage switching means, and the column-driver-reference-voltage switching means,

25 wherein:

a driving voltage supplied to the row driver is a first bipolar driving voltage whose absolute value is a third voltage;

5 a driving voltage supplied to the column driver is a second bipolar driving voltage whose absolute value is a fourth voltage;

the sum of the third voltage and the fourth voltage is a voltage value greater than the voltage value required for setting the state of the cholesteric liquid crystal to a  
10 focal conic state; and

when the control means sets the cholesteric liquid crystal to a planar state, after controlling the row-driver-reference-voltage switching means to set the first reference voltage as the first voltage, the control means controls the  
15 column-driver-reference-voltage switching means to set the second reference voltage as the second voltage, and controls the row driver and the column driver so that the first reference voltage is applied to the row electrodes and the second reference voltage is applied to the column  
20 electrodes; and

in order to set a desired portion of the cholesteric liquid crystal to the focal conic state, the control means controls the row-driver-reference-voltage switching means and the column-driver-reference-voltage switching means to  
25 switch each of the first reference voltage and the second

reference voltage to zero volts, and controls the row driver and the column driver to control supply of the first bipolar driving voltage and the second bipolar driving voltage to the cholesteric liquid crystal.

5       2. (Amended) The display device according to claim 1,  
wherein:

the row driver is supplied with the first bipolar  
driving voltage;

10      the column driver is supplied with the second bipolar  
driving voltage;

the first bipolar driving voltage and the second  
bipolar driving voltage each have a voltage value in which  
the sum of the absolute values of the third voltage and the  
fourth voltage is approximately a half of the first voltage;

15      and

when the control means sets the desired portion of the  
cholesteric liquid crystal to the focal conic state, the  
control means controls the row driver to sequentially apply  
the first bipolar driving voltage so as to scan the row  
20     electrodes, and controls the column driver to selectively  
apply, to the column electrodes, the second bipolar driving  
voltage, which is reverse in polarity to the first bipolar  
driving voltage applied so as to scan the row electrodes.

3. (Amended) A display method for a display device  
25     comprising a display unit which displays information with

cholesteric liquid crystal by applying voltages to row electrodes and column electrodes, the display method including:

- 5        a first reference-voltage applying step of supplying zero volts as a first reference voltage to a row driver which applies a voltage to the row electrodes, and applying the first reference voltage to the row electrodes;
- 10      a second reference-voltage applying step of supplying zero volts as a second reference voltage to a column driver which applies a voltage to the column electrodes, and applying the first reference voltage to the row electrodes;
- 15      a first reference-voltage control step of, in order to set the cholesteric liquid crystal to a planar state, controlling the first reference voltage applied to the row driver to perform switching from zero volts to a first voltage having a voltage value greater than the absolute value of the bipolar driving voltage required for setting the state of the cholesteric liquid crystal to the planar state;
- 20      a second reference-voltage control step of, in order to set the cholesteric liquid crystal to the planar state, controlling the second reference voltage applied to the column driver to perform switching from zero volts to a second voltage whose absolute value is equal to the first voltage and which is reverse in polarity to the first

voltage;

a third switching step of, in order to set a desired portion of the cholesteric liquid crystal to a focal conic state, controlling the first reference voltage applied to 5 the row driver to perform switching from the first voltage to zero volts, and controlling a second driving voltage applied to the column driver to perform switching from the second voltage to zero volts; and

a display control step of, in order to set the desired 10 portion of the cholesteric liquid crystal to the focal conic state, applying a first bipolar driving voltage so as to scan the row electrodes, and selectively applying a second bipolar driving voltage so as to scan the column electrodes, the second bipolar driving voltage having an absolute value 15 equal to the first voltage and being reverse in polarity to the first bipolar driving voltage applied so as to scan the row electrodes,

wherein:

a driving voltage supplied the row driver is the first 20 bipolar driving voltage, whose absolute value is a third voltage;

a driving voltage supplied to the column driver is the second bipolar driving voltage, whose absolute value is a forth voltage; and

25 the sum of the third voltage and the fourth voltage is

a voltage value greater than the voltage value required for setting the state of the cholesteric liquid crystal to a focal conic state.

4. (Amended) A liquid crystal driving circuit for driving 5 liquid crystal display elements including cholesteric liquid crystal, the liquid crystal driving circuit comprising:

a row driver for applying a voltage to row electrodes of the liquid crystal display elements;

10 a column driver for applying a voltage to column electrodes of the liquid crystal display elements;

row-driver-reference-voltage switching means for selectively switching a first reference voltage supplied to the row driver between a first voltage having a voltage value greater than the absolute value of the bipolar driving 15 voltage required to setting the state of the cholesteric liquid crystal to a planar state, and zero volts;

column-driver-reference-voltage switching means for selectively switching a second reference voltage supplied to the column driver between a second voltage whose absolute 20 value is equal to the first voltage and which is reverse in polarity to the first voltage, and zero volts; and

control means for controlling the operation of the row driver and the column driver, the row-driver-reference-voltage switching means, and the column-driver-reference-voltage switching means,

wherein:

a driving voltage supplied to the row driver is a first bipolar driving voltage whose absolute value is a third voltage;

5 a driving voltage supplied to the column driver is a second bipolar driving voltage whose absolute value is a fourth voltage;

the sum of the third voltage and the fourth voltage is a voltage value greater than the voltage value required for  
10 setting the state of the cholesteric liquid crystal to a focal conic state; and

when the control means sets the cholesteric liquid crystal to a planar state, after controlling the row-driver-reference-voltage switching means to set the first reference  
15 voltage as the first voltage, the control means controls the column-driver-reference-voltage switching means to set the second reference voltage as the second voltage, and controls the row driver and the column driver so that the first reference voltage is applied to the row electrodes and the  
20 second reference voltage is applied to the column electrodes; and

in order to set a desired portion of the cholesteric liquid crystal to a focal conic state, the control means controls the row-driver-reference-voltage switching means  
25 and the column-driver-reference-voltage switching means to

switch each of the first reference voltage and the second reference voltage to zero volts, and controls the row driver and the column driver to control supply of the first bipolar driving voltage and the second bipolar driving voltage to  
5 the cholesteric liquid crystal.

5. (Amended) A liquid crystal driving method for a liquid crystal driving circuit which drives liquid crystal display elements including cholesteric liquid crystal by applying voltages to row electrodes and column electrodes, the liquid  
10 crystal driving method including:

a first reference-voltage applying step of supplying zero volts as a first reference voltage to a row driver which applies a voltage to the row electrodes, and applying the first reference voltage to the row electrodes;

15 a second reference-voltage applying step of supplying zero volts as a second reference voltage to a column driver which applies a voltage to the column electrodes, and applying the first reference voltage to the row electrodes;

a first reference-voltage control step of, in order to  
20 set the cholesteric liquid crystal to a planar state, controlling the first reference voltage applied to the row driver to perform switching from zero volts to a first voltage having a voltage value greater than the absolute value of the bipolar driving voltage required for setting  
25 the state of the cholesteric liquid crystal to the planar

state;

a second reference-voltage control step of, in order to set the cholesteric liquid crystal to the planar state, controlling the second reference voltage applied to the  
5 column driver to perform switching from zero volts to a second voltage whose absolute value is equal to the first voltage and which is reverse in polarity to the first voltage;

a third switching step of, in order to set a desired portion of the cholesteric liquid crystal to a focal conic state, controlling the first reference voltage applied to the row driver to perform switching from the first voltage to zero volts, and controlling a second driving voltage applied to the column driver to perform switching from the  
15 second voltage to zero volts; and

a driving-voltage-application control step of, in order to set the desired portion of the cholesteric liquid crystal to the focal conic state, controlling sequential application of a first bipolar driving voltage to the row electrodes,  
20 and controlling selective application, to the column electrodes, of a second bipolar driving voltage having a voltage value which is reverse in polarity to the first bipolar driving voltage applied so as to scan the row electrodes, and whose absolute value is equal to the first  
25 voltage,

wherein:

a driving voltage supplied to the row driver is the first bipolar driving voltage, whose absolute value is a third voltage;

5 a driving voltage supplied to the column driver is the second bipolar driving voltage, whose absolute value is a forth voltage; and

the sum of the third voltage and the fourth voltage is a voltage value greater than the voltage value required for  
10 setting the state of the cholesteric liquid crystal to the focal conic state.

6. (Amended) The display method according to claim 5, wherein the first bipolar driving voltage and the second bipolar driving voltage each have a voltage value in which  
15 the sum of the absolute values of the third voltage and the fourth voltage is approximately a half of the first voltage.

7. (Amended) The liquid crystal driving circuit according to claim 6, wherein:

the row driver is supplied with the first bipolar  
20 driving voltage;

the column driver is supplied with the second bipolar driving voltage;

the first bipolar driving voltage and the second bipolar driving voltage each have a voltage value in which  
25 the sum of the absolute values of the third voltage and the

fourth voltage is approximately a half of the first voltage; and

when the control means sets the desired portion of the cholesteric liquid crystal to the focal conic state, the  
5 control means controls the row driver to sequentially apply the first bipolar driving voltage so as to scan the row electrodes, and controls the column driver to selectively apply, to the column electrodes, the second bipolar driving voltage, which is reverse in polarity to the first bipolar  
10 driving voltage applied so as to scan the row electrodes.

8. (Amended) The liquid crystal driving method according to claim 7, wherein the first bipolar driving voltage and the second bipolar driving voltage each have a voltage value in which the sum of the absolute values of the third voltage  
15 and the fourth voltage is approximately a half of the first voltage.

9. (Cancelled)

10. (Cancelled)